BMP
Retrofit
Pilot Program

February 1, 1999 (Approved)
June 15, 2000 (Revised)

BASIS OF DESIGN REPORT DRAINAGE DESIGN, DISTRICT 11 PS&E

Interstate 5/La Costa Avenue Constructed Wetland

Caltrans Report ID #: CTSW-RT-98-52-A2

Prepared For:

California Department of Transportation
CALTRANS ENVIRONMENTAL PROGRAM
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ACRONYMS

AES	Advanced Engineering Software
ac	Acre
ac-ft	Acre feet
BMP	Best Management Practice
Caltrans	California Department of Transportation
cfs	cubic feet per second
GMP	Caltrans Inlet Type
NRDC	Natural Resources Defense Council
PS&E	Plans, Specifications, and Estimates
RCB	reinforced concrete box
RCP	reinforced concrete pipe

1.0 Introduction

1.1 General

Pursuant to the District 11 Consent Decree, a BMP Retrofit Pilot Program is required to investigate the effectiveness and appropriateness of retrofitting Caltrans facilities with selected Best Management Practices (BMPs). This report documents the design parameters associated with the implementation of a Best Management Practice for storm water discharge from one Caltrans District 11 site. Siting information for this location is provided in the October 1, 1998 addendum to the report entitled, "BMP Retrofit Pilot Program, Composite Siting Study, District 11" dated May 26, 1998, by Robert Bein, William Frost & Associates. The BMP Pilot Project discussed in this report is an extended wet detention pond/wetland.

1.2 Objectives

The purpose of this study is to provide design criteria in support of the construction drawings of the BMP Retrofit Pilot Program project. Specifically, the objectives of this report are as follows:

- Define hydrologic criteria for the design of the BMP.
- Develop discharges for the design conditions.
- Define hydraulic criteria for the design of the BMP.
- Define design parameters for the BMP.
- Provide technical calculations supporting the drainage facility designs shown on the construction drawings.

1.3 Project Location

Project and site reference numbers are as indicated in the program *Scoping Study*, dated May 22, 1998 and *Status Report #1*, dated March 30, 1998. The project was relocated per the October 1, 1998 addendum to the report entitled, "BMP Retrofit Pilot Program, Composite Siting Study, District 11" dated May 26, 1998.

1.3.1 Project 4, Site1: Northbound I-5/La Costa Avenue Constructed Wetland

The constructed wetland BMP site is located at the Northbound I-5/La Costa Avenue interchange. The wetland site is located in the area bounded by the I-5 (northbound)/ La Costa Avenue off-ramp to the west and south, La Costa Avenue to the north, and Piraeus Street to the east.

1.4 Construction Cost

The estimated cost of construction for the site is $441,830. A copy of the Engineer's Estimate is included in Appendix E.

2.0 HYDROLOGIC CHARACTERISICS

2.1 Rainfall Characteristics

San Diego County has a Mediterranean-type climate characterized by long, dry summers and mild winters. The average annual precipitation is about 12 inches and increases to about 18 inches in elevations above 2000 feet. Most of the precipitation occurs from November through March, with little or no rainfall from May through October. The average rainfall depth, calculated using the rainfall obtained from the Averaged Mass Rainfall Plotting Sheets (Appendix A), for a 1-year, 24-hour storm is 1.34 inches.

2.2 Soil Types and Infiltration

Based on the U.S. Soil Conservation Services criteria, soils are classified into four hydrological soil groups: A, B, C, and D, where A is the most pervious with low runoff potential (such as sand or gravel) and D is the least pervious with high runoff potential (such as clay soils).

2.3 Methodology and Procedure

a. The County of San Diego Department of Public Works, Flood Control Division Hydrology Manual, dated January 5, 1985 was the procedure used for hydrologic computations.
b. Hydrologic calculations were performed using the Advanced Engineering Software (AES). Rational Method computer program for the 1-year and 25-year design storms.
c. Rainfall intensities were obtained from the isohyetals provided in the hydrology manual. The 1-year 24-hour storms were extrapolated from the 2-year and the 24-hour isohyetals. (See Appendix A.)
d. The unit hydrograph procedure was used to compute storm water runoff volumes. User specified rainfall-intensity data was determined by plotting the 1-year and 25-year, 24-hour storm data on a mass rainfall plotting sheet. The data pairs were then selected and input into the AES Small Area Unit Hydrograph Modeling computer program.

2.4 Constructed Wetland Permanent Pool Volume Design Methodology

A deviation was made from the original design guidelines for the volume calculations of the permanent pool as outlined in a memorandum entitled “Constructed Wetlands”. A copy of the memorandum is located in Appendix F. According to these guidelines “the permanent pool volume is equal to one-half of the runoff volume of the wettest month of the year”. This volume was then to be increased by a factor of 10% to “accommodate reduction in the available storage volume due to deposition of solids in the time between full-scale maintenance activities”. Since these permanent pool volume guidelines were originally formulated for a 6-month design storm, the calculated volume for a 1-year, 24-hour design storm was approximated by doubling the 6-month design storm value (Appendix F).

The ratio of permanent pool volume to water quality volume was found to be 2.0 (permanent pool: 1-yr, 24-hr = 0.42 ac-ft: 0.21 ac-ft). According to FHWA, the minimum ratio should be 3.0. Since the FHWA's volume requirements were higher, the permanent pool volume was designed according to the FHWA's recommendations to maximize constituent removal.

$$\mathbf{V_{PP} = 3 \times (V_{WQ})}$$

Where: V_{PP} = permanent pool volume
V_{WQ} = 1-year, 24-hour water quality capture volume

2.5 Summary of Results

The hydrology map is located in Appendix C. The hydrology map shows the tributary area for drainage to the BMP Retrofit site. Appendix A contains the result of the AES hydrologic calculations.

3.0 WATER QUALITY DESIGN DISCUSSION AND ASSUMPTIONS

3.1 Project 4, Site 1: Northbound I-5/La Costa Avenue Constructed Wetland

The pilot is an off-line, earthen, extended wet detention pond/wetland with a tributary area that includes mainline freeway and the wetland surface area for a total tributary area of 4.2 acres. Inflow to the basin occurs at a single point, the total computed 1-year, 24-hour water quality design volume is 0.21 acre-feet. Flow is discharged through a single orifice cut into the sidewall of an 8” PVC. The orifice was set at the permanent pool water surface elevation. The resulting orifice diameter and elevation relative to the basin invert are shown in the Table 1. The orifice calculation is provided in Appendix B.

Table 1

Storm frequency	*Number of orifices*	*Orifice Diameter (in)*	*Orifice Invert (ft)*
1-year	1	3.08	14.265

A debris screen (1/2” openings) at the end of the submerged end of the 8” PVC prevents the orifice from clogging. The weir of the water quality outlet structure riser was set at the 1-year, 24-hour storage elevation. Less frequent storms may discharge through the rock slope protection spillway adjacent to the existing trapezoidal channel. The area surrounding the basin which is disturbed during construction will be stabilized to reduce erosion potential using a hydroseed mix as indicated in the project specifications, Design Directive Memorandum No. 6, and page three of the planting recommendations by Martha Blane & Associates, dated May 12, 1998 (Appendix

D.)

Maintenance access is provided at the perimeter of the basin. Storm water samples will be taken using automated equipment at both the basin inflow and outflow points. The discharge to the basin outlets onto a grouted riprap pad, which serves to reduce the outlet velocity and spread the flow. The basin has an average flow length:width ratio of 3:1.

The basin was designed as an offline facility to capture the tributary watershed for water quality purposes. A canal gate at the basin invert is provided in the water quality outlet structure to drain the basin should clogging of the outlet orifice occur. A 30-foot clear zone setback to the adjacent ramp and the freeway mainline was maintained adjacent to the basin. An existing concrete driveway provides access to the maintenance road located at the perimeter of the basin. Basin side slopes vary between 1:3 and 1:6. The design residence time is 24-hours for the 1-year storm frequency, which translates to a minimum of a two week detention time when, mixed with the permanent pool volume. The average permanent pool depth is 2.3 feet. The water quality pool depth is 0.63 feet.

3.1.1 Tributary Drainage Area

The location selected for the Pilot Project is an infield area bounded by an existing Caltrans ramp and frontage road. The water quality runoff tributary to the BMP was diverted to the basin by way of a new storm drain system. The northbound I-5 mainline is tributary to a series of existing 24-inch RCP cross culverts which discharge to a concrete channel adjacent to the southbound mainline right-of-way. A portion of this mainline flow has been intercepted and directed to the wet basin site for treatment. The infield runoff is tributary to an existing trapezoidal concrete lined channel located within the infield area.

The mainline and infield tributary areas discharge to the Batiquitos Lagoon via an existing double 6’x5’ RCB that crosses La Costa Avenue.

Additional drainage area within the Caltrans right-of-way could be not be diverted to the proposed constructed wetland location due to the site constraints. The available site area has been completely utilized for the current design. The interception of additional tributary area would require additional site area to increase the pond surface area, or reconstruction of the downstream storm drain system at a lower elevation to allow a deeper pond invert elevation. Neither of these two alternatives is practical.

3.1.2 Site Constraints

The site is constrained by the existing Caltrans La Costa Avenue offramp to the west and existing Caltrans right-of-way to the north and east. An existing concrete lined trapezoidal channel is also located adjacent to the easterly basin boundary, further constraining the site. The design of the constructed wetland maximized the available area of the site. The permanent pool inflow and the water quality outflow elevations were controlled by the connections to the adjacent concrete lined trapezoidal channel. Consequently the water quality tributary area and subsequent basin design volume were restricted by the site geometry.

3.2 Selection of Plant Materials

A specialist, familiar with wetland plant species and water quality treatment systems was consulted to develop the plant palette for the project. The wet basin vegetation design consists of five planting zones. The designed water surface elevations affect zones 2 and 3, the shallow water bench and zone of periodic inundation respectively. The shallow water bench was initially specified for vegetation planted in water depths of 6'' to 12". This zone was extended to the permanent pool water surface elevation, depth of 0", coincident with the water quality orifice invert. The zone of periodic inundation is the temporary water storage volume impounded between the permanent pool and the overflow weir, i.e. the water quality storage volume. The complete plant listing is provided in Appendix G. Selection criteria for the plants included native species and those suitable for storm water treatment. Placement of the plants is indicated on the project highway planting /landscape plan.

4.0 HYDRAULIC ANALYSIS

4.1 Design Characteristics

The constructed wetland has been designed to conform to the physical constraints of the site area, maximizing the available surface area. The site has been designed in two separate cells; the forebay and the wet extended detention pond/wetland.

4.1.1 Forebay

The forebay's primary functions are to trap coarse sediments and to disperse runoff evenly to the wet basin. The forebay was designed to accommodate approximately 25 percent of the total basin volume. Other forebay design criteria include:

- Reinforce slope protection for energy dissipation and flow dispersion.
- Side slopes of 4:1 for erosion control.
- Shallow bench (1-foot depth) around the sides of the forebay to enhance vegetation growth and public safety.
- Gabion wall spillway to disperse the outflow evenly and provide longer retention time.
- Maintenance access road directly to the invert of the forebay.
- Two separate inlets one for the perennial source water and one for water quality design inflow.

4.1.2 Wet basin

The wet basin's primary function is to create a favorable environment for physical, biological, and chemical flocculation of storm water runoff. Other wet basin characteristics incorporated into the current design include:

- A meandering flowpath to increase residence time and provide a greater runoff-to-soil (and vegetation) interface.
- Two wetland berms to increase flowpath.
- Side slopes of 1:3 between the basin invert and the shallow bench for erosion control and increased wetted perimeter.
- A 1:6 side slope around the sides of the wet basin to enhance vegetation growth and public safety and increase the littoral zone area.
- A diverse selection of plant species.
- An expanded width near the outlet of the basin to further reduce velocity and trap finer sediment.
- Basin invert designed to allow complete draining of the basin for maintenance purposes.
- A restricted riser outlet designed for a 14-day residence time (below the permanent pool water surface) to provide circulation within the permanent pool.
- An extended detention riser outlet (same as above) designed to provide 24 hours of retention time (below the maximum water quality design water surface and above the permanent pool surface) and effective 2-week average detention time of incoming storm water runoff.
- A rock slope protected spillway at the maximum design water quality water surface.
- A canal gate located in the water quality outlet structure to provide basin drainage. An additional canal gate was provided at the perennial inflow for basin maintenance.

4.2 Design Criteria

Technical references include the Caltrans Highway Design Manual (Caltrans 1997), and the Caltrans Storm Water Quality Handbook, Planning and Design Staff Guide (Caltrans 1996) and the project *Scoping Study*.

4.3 Methodology and Design Procedures

a. The orifice opening was calculated using the orifice equation cited in the Caltrans Storm Water Quality Handbook, Planning and Design Staff Guide.
b. Water quality volume drawdown time of 24-hours.

4.4 Summary of Results

The constructed wetland water quality outlet structure will control the water quality inflow to achieve the desired detention time. The rock slope protected spillway will discharge storm events greater than the one year water quality volume with less attenuation. The constructed wetland has been designed as an offline device. The peak water quality inflow will be directed to the wetland, the portion of the storm with a peak discharge in excess of the 1-year 24-hour storm will bypass the facility through the existing storm drain system. Hydraulic calculations are provided in Appendix B.

REFERENCES

BMP Retrofit Pilot Program, Composite Siting Study, District 11 prepared by Robert Bein, William Frost and Associates. May 26, 1998.

BMP Retrofit Pilot Program, Scoping Study, Caltrans District 11 prepared by Robert Bein, William Frost and Associates. May 22, 1998.

California Department of Transportation (Caltrans), *Highway Design Manual.* Fifth Edition. March 1997.

Caltrans Storm Water Quality Handbook, Planning and Design Staff Guide (Caltrans 1996).

County of San Diego, Department of Public Works, Flood Control Division, Hydrology Manual. January 1985.

Pre-Construction Geotechnical Evaluation Report, Caltrans Storm Water Runoff Study, Retrofit Facilities, District 11, La Costa Wet Basin, San Diego County California prepared by Group Delta Consultants, Inc. November 13, 1998.

U.S. Department of Transportation, Federal Highway Administration, *Evaluation and Management of Highway Runoff Water Quality*. Publication No. FHWA-PD-96-032. June 1996.

APPENDIX A
HYDROLOGY CALCULATIONS

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949.472.3505 • FAX 949.472.8373

JOB CALTRANS BMP - 34358
SHEET NO. ______ OF ______
CALCULATED BY AMW DATE ______
CHECKED BY ______ DATE ______
SCALE ______

NB I-5 / LA COSTA AVE

1-YR STORM EXTRAPOLATION

2-YR-24 HR ISOPLUVIAL $1.7 \frac{IN}{HR}$
2-YR-6 HR ISOPLUVIAL $1.2 \frac{IN}{HR}$

2-YR 60-MIN INTENSITY $= 0.61 \frac{IN}{HR}$ IDF CURVE
1-YR 60-MIN INTENSITY $= 0.48 \frac{IN}{HR}$

$$\text{FACTOR} = \frac{1\text{-YR}}{2\text{-YR}} = \frac{0.48}{0.61} = 0.787$$

$\Rightarrow$ 1-YR 24-HR: $1.7 \frac{IN}{HR}(0.787) = 1.34 \frac{IN}{HR}$

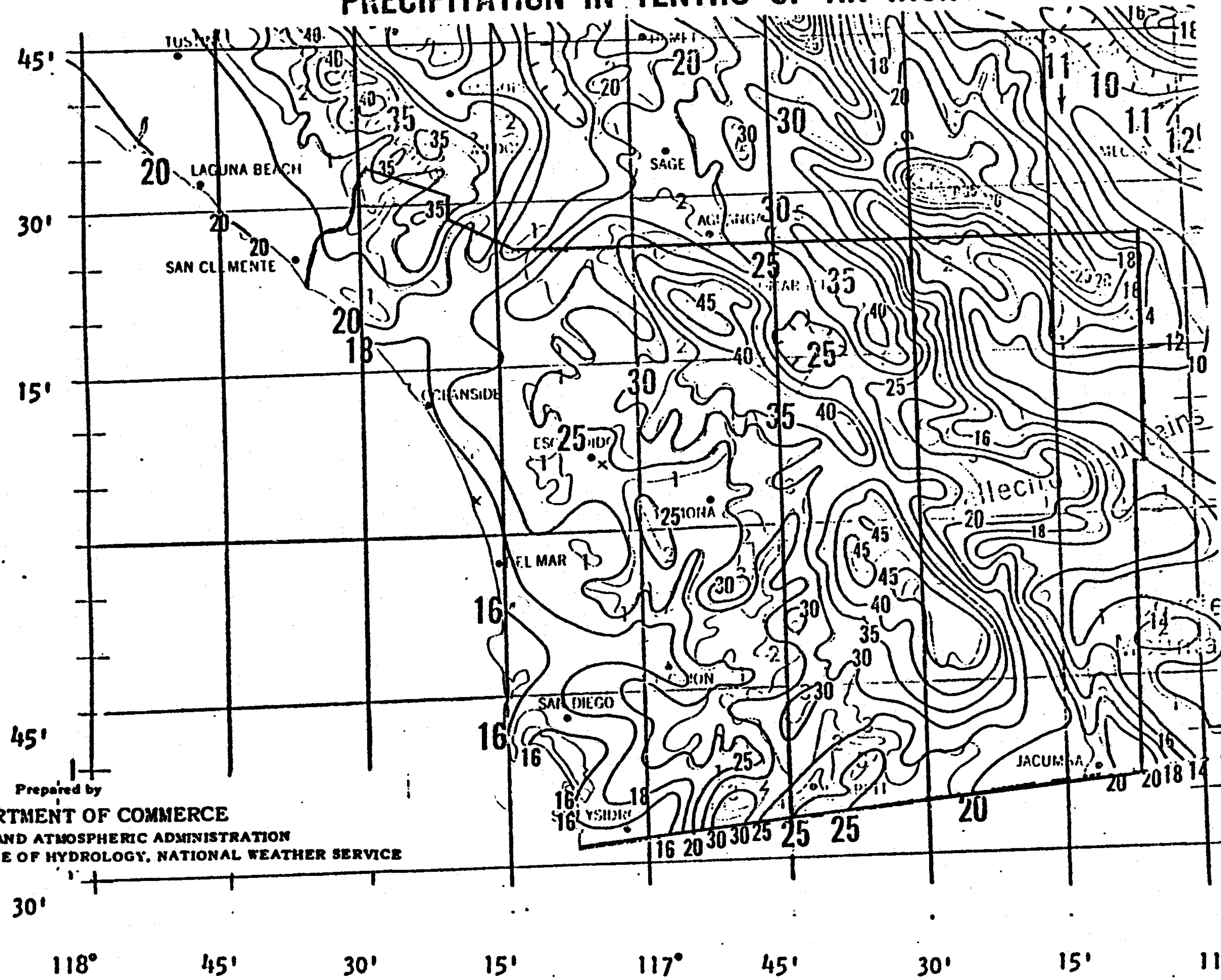
1-YR-6-HR: $1.2 \frac{IN}{HR}(0.787) = 0.94 \frac{IN}{HR}$

COUNTY OF SAN DIEGO
DEPARTMENT OF SANITATION &
FLOOD CONTROL

2-YEAR 24-HOUR PRECIPITATION

—10— ISOPLUVIALS OF 2-YEAR 24-HOUR

PRECIPITATION IN TENTHS OF AN INCH

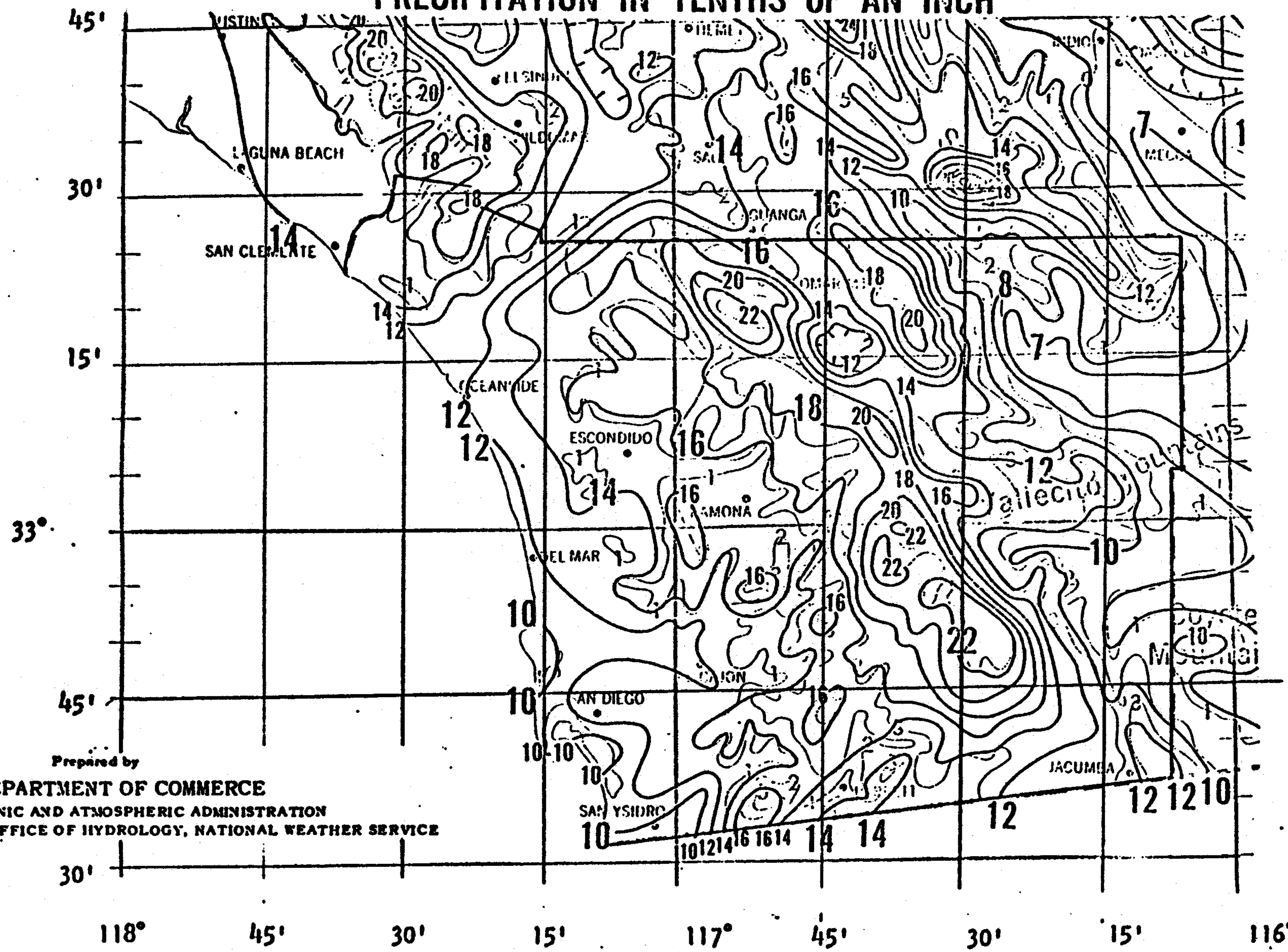


Prepared by
U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
SPECIAL STUDIES BRANCH, OFFICE OF HYDROLOGY, NATIONAL WEATHER SERVICE

COUNTY OF SAN DIEGO
DEPARTMENT OF SANITATION &
FLOOD CONTROL

2-YEAR 6-HOUR PRECIPITATION

—10—ISOPLUVIALS OF 2-YEAR 6-HOUR PRECIPITATION IN TENTHS OF AN INCH



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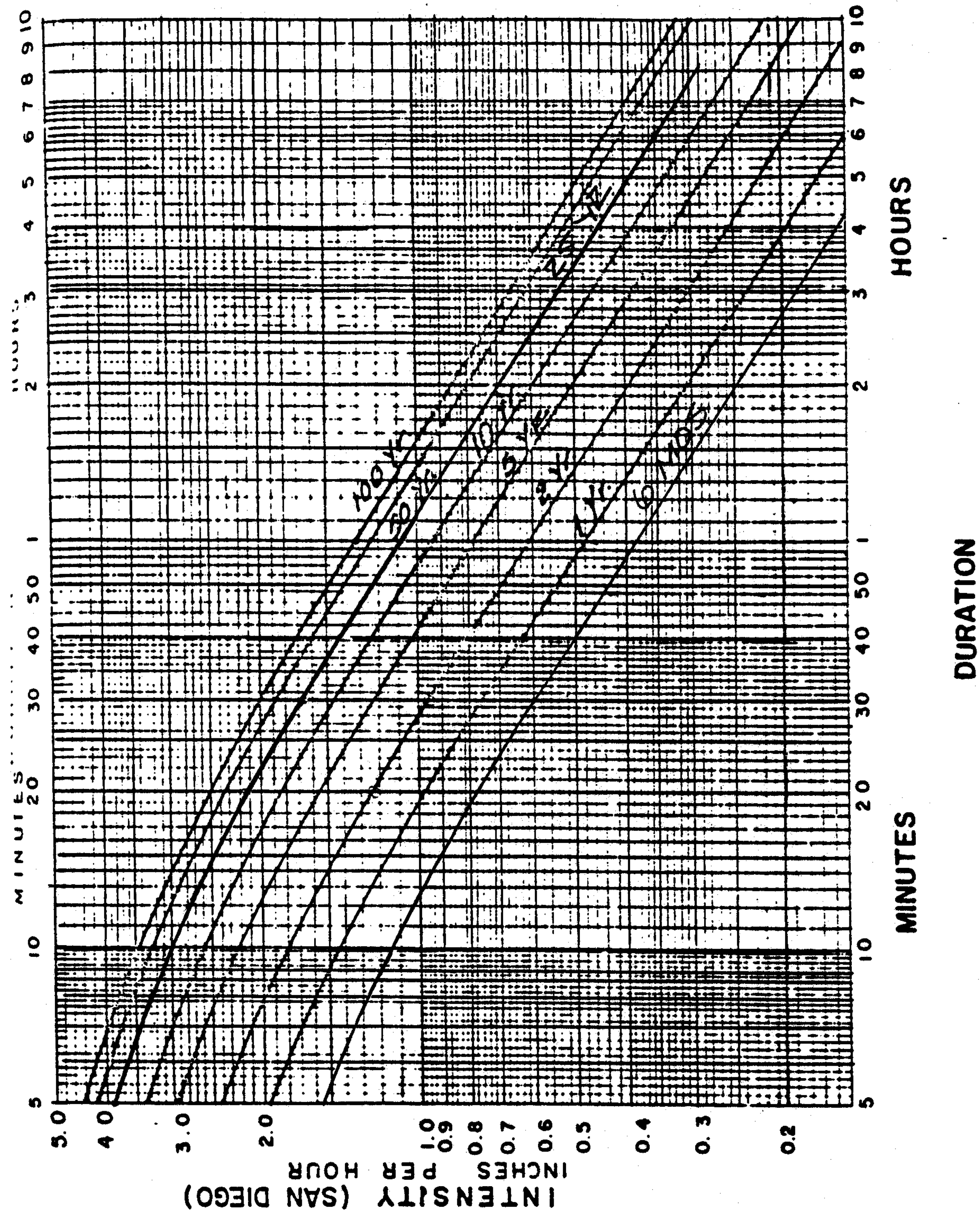
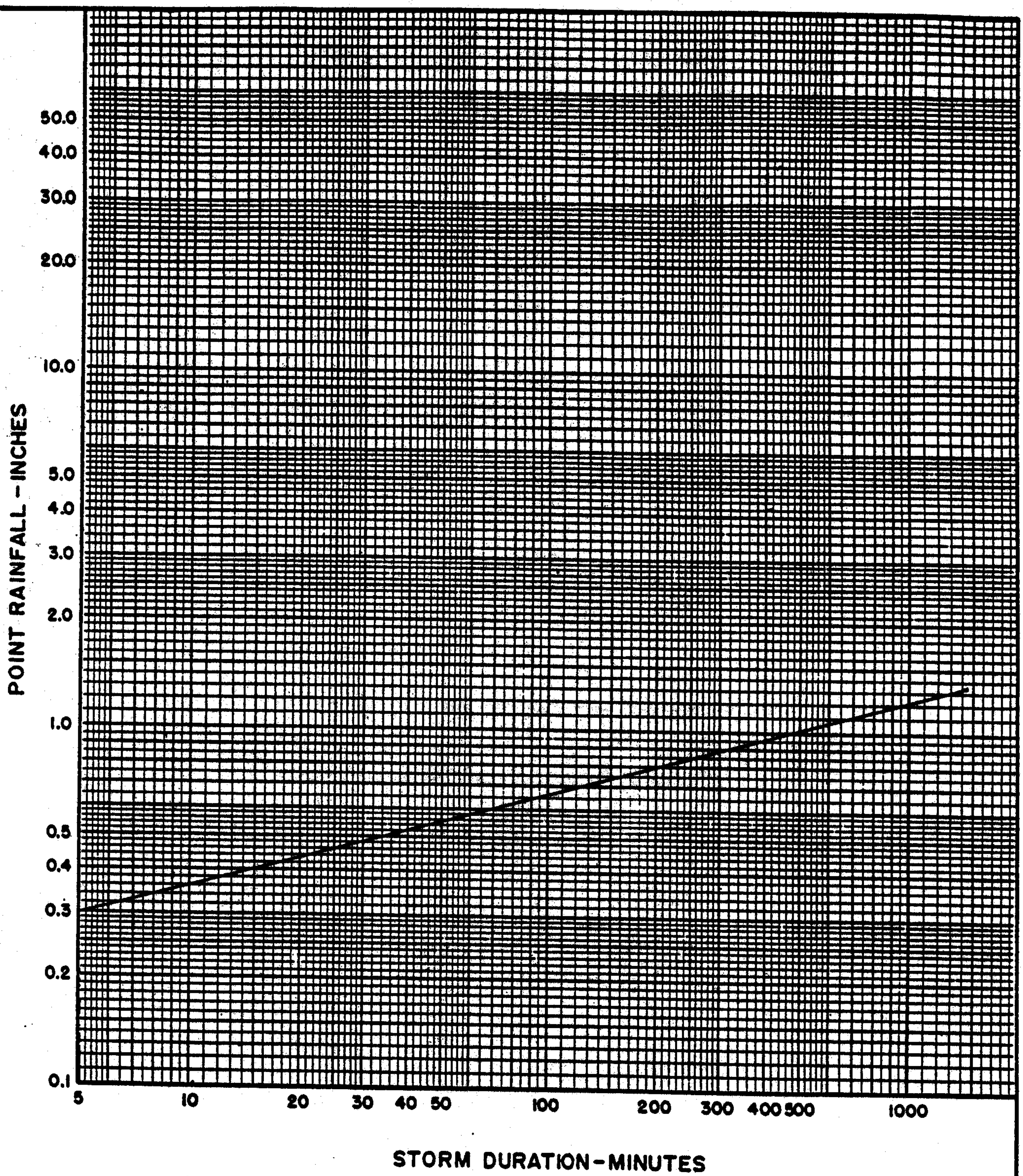


ELEV.	FACTOR
0–1500	1.00
1500–3000	1.25
3000–4000	1.42
4000–5000	1.60
5000–6000	1.70
DESERT	1.25

To obtain correct intensity, multiply intensity on chart by factor for design elevation.

RAINFALL INTENSITY – DURATION – FREQUENCY CURVES for COUNTY OF SAN DIEGO

APPENDIX XI



PROJECT LOCATION NB I-5 / LA COSTA AVE

NOTES

AREA - AVERAGED MASS RAINFALL PLOTTING SHEET

Figure B-7

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****************************************************************************

           RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
           Reference: SAN DIEGO COUNTY FLOOD CONTROL DISTRICT
                         1985,1981 HYDROLOGY MANUAL
        (c) Copyright 1982-96 Advanced Engineering Software (aes)
            Ver. 1.5A  Release Date: 01/01/96  License ID 1264

                           Analysis prepared by:

              Robert Bein, William Frost & Associates
                         14725 Alton Parkway
                          Irvine, CA  92618
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 ************************** DESCRIPTION OF STUDY **************************
 * JN34358 I-5/LA COSTA AVE CONSTRUCTED WETLAND   *
 * 1-YR STORM FREQUENCY, WATER QUALITY VOLUME   *
 * AMW   *
 ****

  FILE NAME: WBQL_FIN.DAT
  TIME/DATE OF STUDY: 23:34   1/26/1999

  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:

  USER SPECIFIED STORM EVENT(YEAR) =   1.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) = 18.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = .95
  RAINFALL-INTENSITY ADJUSTMENT FACTOR = 1.000
  *USER SPECIFIED:
  NUMBER OF [TIME,INTENSITY] DATA PAIRS = 9
   1)   5.000; 1.950
   2) 10.000; 1.430
   3) 20.000;   .960
   4) 30.000;   .770
   5) 40.000;   .630
   6) 50.000;   .545
   7) 60.000;   .480
   8) 120.000;   .320
   9) 180.000;   .235
  SAN DIEGO HYDROLOGY MANUAL "C"-VALUES USED
  NOTE: ONLY PEAK CONFLUENCE VALUES CONSIDERED

****
  FLOW PROCESS FROM NODE   1.00 TO NODE   2.00 IS CODE = 21

  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
==
  SOIL CLASSIFICATION IS "B"
  MULTI-UNITS DEVELOPMENT RUNOFF COEFFICIENT = .5000
  INITIAL SUBAREA FLOW-LENGTH =   300.00
  UPSTREAM ELEVATION =   77.26
  DOWNSTREAM ELEVATION =   70.43
  ELEVATION DIFFERENCE =   6.83
  URBAN SUBAREA OVERLAND TIME OF FLOW(MINUTES) =   14.220
     1 YEAR RAINFALL INTENSITY(INCH/HOUR) = 1.232
  SUBAREA RUNOFF(CFS) =   .35
  TOTAL AREA(ACRES) =   .57   TOTAL RUNOFF(CFS) =   .35

****
  FLOW PROCESS FROM NODE   2.00 TO NODE   3.00 IS CODE =   6

  >>>>>COMPUTE STREETFLOW TRAVELTIME THRU SUBAREA<<<<<
==
  UPSTREAM ELEVATION =   70.43   DOWNSTREAM ELEVATION =   56.76
  STREET LENGTH(FEET) =   651.06   CURB HEIGHT(INCHES) = 6.
  STREET HALFWIDTH(FEET) = 58.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK = 48.00
  INTERIOR STREET CROSSFALL(DECIMAL) =   .020
  OUTSIDE STREET CROSSFALL(DECIMAL) =   .020
```
```

```
SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1

       **TRAVELTIME COMPUTED USING MEAN FLOW(CFS) =      .79
  STREETFLOW MODEL RESULTS:
       STREET FLOWDEPTH(FEET) =   .22
       HALFSTREET FLOODWIDTH(FEET) =    4.59
       AVERAGE FLOW VELOCITY(FEET/SEC.) =    2.40
       PRODUCT OF DEPTH&VELOCITY =     .52
STREETFLOW TRAVELTIME(MIN) =   4.52   TC(MIN) =  18.74

   1 YEAR RAINFALL INTENSITY(INCH/HOUR) =  1.019
SOIL CLASSIFICATION IS "B"
MULTI-UNITS DEVELOPMENT RUNOFF COEFFICIENT = .5000
SUBAREA AREA(ACRES) =    1.69   SUBAREA RUNOFF(CFS) =      .86
SUMMED AREA(ACRES) =    2.26   TOTAL RUNOFF(CFS) =      1.21
END OF SUBAREA STREETFLOW HYDRAULICS:
DEPTH(FEET) =  .25   HALFSTREET FLOODWIDTH(FEET) =  6.36
FLOW VELOCITY(FEET/SEC.) =  2.32   DEPTH*VELOCITY =     .59

****************************************************************************
FLOW PROCESS FROM NODE      3.00 TO NODE      4.00 IS CODE =   3
----------------------------------------------------------------------------
>>>>>COMPUTE PIPEFLOW TRAVELTIME THRU SUBAREA<<<<<
>>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 18.000
DEPTH OF FLOW IN  18.0 INCH PIPE IS   3.9 INCHES
PIPEFLOW VELOCITY(FEET/SEC.) =   4.3
UPSTREAM NODE ELEVATION =    56.76
DOWNSTREAM NODE ELEVATION =    52.35
FLOWLENGTH(FEET) =   325.00   MANNING'S N =  .013
ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
PIPEFLOW THRU SUBAREA(CFS) =       1.21
TRAVEL TIME(MIN.) =    1.25    TC(MIN.) =  19.98

****************************************************************************
FLOW PROCESS FROM NODE      4.00 TO NODE      4.00 IS CODE =   8
----------------------------------------------------------------------------
>>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   1 YEAR RAINFALL INTENSITY(INCH/HOUR) =   .961
SOIL CLASSIFICATION IS "B"
MULTI-UNITS DEVELOPMENT RUNOFF COEFFICIENT = .5000
SUBAREA AREA(ACRES) =      .86   SUBAREA RUNOFF(CFS) =      .41
TOTAL AREA(ACRES) =     3.12   TOTAL RUNOFF(CFS) =     1.63
TC(MIN) =  19.98

****************************************************************************
FLOW PROCESS FROM NODE      4.00 TO NODE      5.00 IS CODE =   3
----------------------------------------------------------------------------
>>>>>COMPUTE PIPEFLOW TRAVELTIME THRU SUBAREA<<<<<
>>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 18.000
DEPTH OF FLOW IN  18.0 INCH PIPE IS   3.9 INCHES
PIPEFLOW VELOCITY(FEET/SEC.) =   5.8
UPSTREAM NODE ELEVATION =    52.35
DOWNSTREAM NODE ELEVATION =    44.28
FLOWLENGTH(FEET) =   325.00   MANNING'S N =  .013
ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
PIPEFLOW THRU SUBAREA(CFS) =       1.63
TRAVEL TIME(MIN.) =     .93    TC(MIN.) =  20.91

****************************************************************************
FLOW PROCESS FROM NODE      5.00 TO NODE      5.00 IS CODE =   8
----------------------------------------------------------------------------
>>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   1 YEAR RAINFALL INTENSITY(INCH/HOUR) =   .943
SOIL CLASSIFICATION IS "B"
```

```
  INDUSTRIAL DEVELOPMENT RUNOFF COEFFICIENT = .8500
  SUBAREA AREA(ACRES) =       .52   SUBAREA RUNOFF(CFS) =      .42
  TOTAL AREA(ACRES) =      3.64   TOTAL RUNOFF(CFS) =     2.04
  TC(MIN) =  20.91

****************************************************************************
  FLOW PROCESS FROM NODE      5.00 TO NODE      6.00 IS CODE =   3
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPEFLOW TRAVELTIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 18.000
  DEPTH OF FLOW IN  18.0 INCH PIPE IS   4.7 INCHES
  PIPEFLOW VELOCITY(FEET/SEC.) =   5.6
  UPSTREAM NODE ELEVATION =    44.28
  DOWNSTREAM NODE ELEVATION =    39.85
  FLOWLENGTH(FEET) =   240.80   MANNING'S N =  .013
  ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPEFLOW THRU SUBAREA(CFS) =       2.04
  TRAVEL TIME(MIN.) =    .71    TC(MIN.) =  21.62

****************************************************************************
  FLOW PROCESS FROM NODE      6.00 TO NODE      7.00 IS CODE =   3
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPEFLOW TRAVELTIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 18.000
  DEPTH OF FLOW IN  18.0 INCH PIPE IS   3.3 INCHES
  PIPEFLOW VELOCITY(FEET/SEC.) =   9.0
  UPSTREAM NODE ELEVATION =    39.85
  DOWNSTREAM NODE ELEVATION =    14.22
  FLOWLENGTH(FEET) =   366.40   MANNING'S N =  .013
  ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPEFLOW THRU SUBAREA(CFS) =       2.04
  TRAVEL TIME(MIN.) =    .68    TC(MIN.) =  22.30

****************************************************************************
  FLOW PROCESS FROM NODE      7.00 TO NODE      7.00 IS CODE =   8
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
     1 YEAR RAINFALL INTENSITY(INCH/HOUR) =    .916
  SOIL CLASSIFICATION IS "B"
  RURAL DEVELOPMENT RUNOFF COEFFICIENT = .3500
  SUBAREA AREA(ACRES) =       .56   SUBAREA RUNOFF(CFS) =      .18
  TOTAL AREA(ACRES) =      4.20   TOTAL RUNOFF(CFS) =     2.22
  TC(MIN) =  22.30
============================================================================
  END OF STUDY SUMMARY:
  PEAK FLOW RATE(CFS) =       2.22   Tc(MIN.) =    22.30
  TOTAL AREA(ACRES) =       4.20
============================================================================
  END OF RATIONAL METHOD ANALYSIS
```

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PROFESSIONAL ENGINEERS, PLANNERS & SURVEYORS
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714.472.3505 • FAX 714.472.8373

JOB 34358 - I-5 / LA COSTA AVE WET BASIN
SHEET NO. ______ OF ______
CALCULATED BY AMW DATE 1298
CHECKED BY ______ DATE ______
SCALE ______

LOSS RATE CALCULATION

SOIL GROUP B

$F_P = 0.30$

$A_P = \frac{2.17\ AC}{4.20} = 0.5167$

PAVEMENT AREA = 2.03 AC
PERVIOUS AREA = 4.20 - 2.03
= 2.17 AC

$F_M = A_P F_P$
$= 0.5167 (0.30)$
$= 0.1550$

$I_A = 0.25$

$S = \frac{1000}{CN} - 10$

CN = 90 ROADWAY
86 SLOPES
87.9 WEIGHTED

$S = \frac{1000}{87.9} - 10$
$= 1.37$

$I_A = 0.2(1.37)$
$= 0.27$

$$Y_1 = \frac{(P_{24} - I_A)^2}{(P_{24} - I_A + S)P_{24}} = \frac{(1.34 - 0.27)^2}{(1.34 - 0.27 + 1.37)1.34} = 0.3502$$

$\overline{Y} = 1 - Y$
$= 1 - 0.3502 = 0.6498$

```
***************************************************************************
                     SMALL AREA UNIT HYDROGRAPH MODEL

         (C) Copyright 1989-96 Advanced Engineering Software (aes)
             Ver. 6.1  Release Date: 01/01/98  License ID 1264

                          Analysis prepared by:

                Robert Bein, William Frost & Associates
                          14725 Alton Parkway
                        Irvine, California  92618
```

```
    RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
    TOTAL CATCHMENT AREA(ACRES) =     4.20
    SOIL-LOSS RATE, Fm,(INCH/HR) =  0.155
    LOW LOSS FRACTION = 0.650
    TIME OF CONCENTRATION(MIN.) = 22.30
    RATIONAL METHOD PEAK FLOW RATE (DEFINED BY USER)
    IS USED FOR SMALL AREA PEAK Q
    USER SPECIFIED RAINFALL VALUES ARE USED
    RETURN FREQUENCY(YEARS) =   2
       5-MINUTE POINT RAINFALL VALUE(INCHES) =  0.30
      30-MINUTE POINT RAINFALL VALUE(INCHES) =  0.49
       1-HOUR   POINT RAINFALL VALUE(INCHES) =  0.59
       3-HOUR   POINT RAINFALL VALUE(INCHES) =  0.78
       6-HOUR   POINT RAINFALL VALUE(INCHES) =  0.94
      24-HOUR   POINT RAINFALL VALUE(INCHES) =  1.34

---------------------------------------------------------------------------

    TOTAL CATCHMENT   RUNOFF  VOLUME(ACRE-FEET) =      0.21
    TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) =      0.26

***************************************************************************
  TIME     VOLUME       Q    0.         2.5        5.0        7.5       10.0
 (HOURS)    (AF)      (CFS)
---------------------------------------------------------------------------
  0.018    0.0000      0.00  Q          .          .          .          .
  0.390    0.0003      0.02  Q          .          .          .          .
  0.762    0.0009      0.02  Q          .          .          .          .
  1.133    0.0015      0.02  Q          .          .          .          .
  1.505    0.0021      0.02  Q          .          .          .          .
  1.877    0.0027      0.02  Q          .          .          .          .
  2.248    0.0033      0.02  Q          .          .          .          .
  2.620    0.0040      0.02  Q          .          .          .          .
  2.992    0.0046      0.02  Q          .          .          .          .
  3.363    0.0053      0.02  Q          .          .          .          .
  3.735    0.0060      0.02  Q          .          .          .          .
  4.107    0.0067      0.02  Q          .          .          .          .
  4.478    0.0074      0.02  Q          .          .          .          .
  4.850    0.0082      0.02  Q          .          .          .          .
  5.222    0.0089      0.02  Q          .          .          .          .
  5.593    0.0097      0.03  Q          .          .          .          .
  5.965    0.0105      0.03  Q          .          .          .          .
  6.337    0.0113      0.03  Q          .          .          .          .
  6.708    0.0121      0.03  Q          .          .          .          .
  7.080    0.0130      0.03  Q          .          .          .          .
  7.452    0.0139      0.03  Q          .          .          .          .
  7.823    0.0148      0.03  Q          .          .          .          .
  8.195    0.0157      0.03  Q          .          .          .          .
  8.567    0.0167      0.03  Q          .          .          .          .
  8.938    0.0177      0.03  Q          .          .          .          .
  9.310    0.0188      0.03  Q          .          .          .          .
  9.682    0.0199      0.04  Q          .          .          .          .
 10.053    0.0210      0.04  Q          .          .          .          .
 10.425    0.0222      0.04  Q          .          .          .          .
 10.797    0.0235      0.04  Q          .          .          .          .
 11.168    0.0248      0.04  Q          .          .          .          .
 11.540    0.0262      0.05  Q          .          .          .          .
 11.912    0.0277      0.05  Q          .          .          .          .
 12.283    0.0292      0.05  Q          .          .          .          .
```

```
12.655      0.0310      0.06  Q         .         .         .         .
13.027      0.0329      0.06  Q         .         .         .         .
13.398      0.0349      0.07  Q         .         .         .         .
13.770      0.0372      0.08  Q         .         .         .         .
14.142      0.0397      0.09  Q         .         .         .         .
14.513      0.0425      0.09  Q         .         .         .         .
14.885      0.0457      0.12  Q         .         .         .         .
15.257      0.0496      0.14  Q         .         .         .         .
15.628      0.0551      0.22  Q         .         .         .         .
16.000      0.0640      0.36 .Q         .         .         .         .
16.372      0.1251      3.62  .         .   Q     .         .         .
16.743      0.1832      0.16  Q         .         .         .         .
17.115      0.1873      0.10  Q         .         .         .         .
17.487      0.1902      0.08  Q         .         .         .         .
17.858      0.1925      0.07  Q         .         .         .         .
18.230      0.1944      0.06  Q         .         .         .         .
18.602      0.1960      0.05  Q         .         .         .         .
18.973      0.1974      0.04  Q         .         .         .         .
19.345      0.1987      0.04  Q         .         .         .         .
19.717      0.1998      0.04  Q         .         .         .         .
20.088      0.2009      0.03  Q         .         .         .         .
20.460      0.2018      0.03  Q         .         .         .         .
20.832      0.2028      0.03  Q         .         .         .         .
21.203      0.2036      0.03  Q         .         .         .         .
21.575      0.2044      0.03  Q         .         .         .         .
21.947      0.2052      0.02  Q         .         .         .         .
22.318      0.2059      0.02  Q         .         .         .         .
22.690      0.2066      0.02  Q         .         .         .         .
23.062      0.2073      0.02  Q         .         .         .         .
23.433      0.2080      0.02  Q         .         .         .         .
23.805      0.2086      0.02  Q         .         .         .         .
24.177      0.2092      0.02  Q         .         .         .         .
24.548      0.2095      0.00  Q         .         .         .         .
---------------------------------------------------------------------------
1
```

APPENDIX B
HYDRAULIC CALCULATIONS

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714.472.3505 • FAX 714.472.8373

JOB 34358 - I-5 / LA COSTA AVE
SHEET NO. ______ OF ______
CALCULATED BY AMW DATE 12 98
CHECKED BY ______ DATE ______
SCALE ______

BASIN CALCULATIONS

1-YR WATER QUALITY RUNOFF VOLUME $V_{WQ} = 0.21$ AC-FT

PERMANENT POOL VOLUME

$V_{PP} = 3V_{WQ}$

$= 3(0.21 \text{ AC-FT})$

$= 0.63$ AC-FT

TOTAL BASIN VOLUME

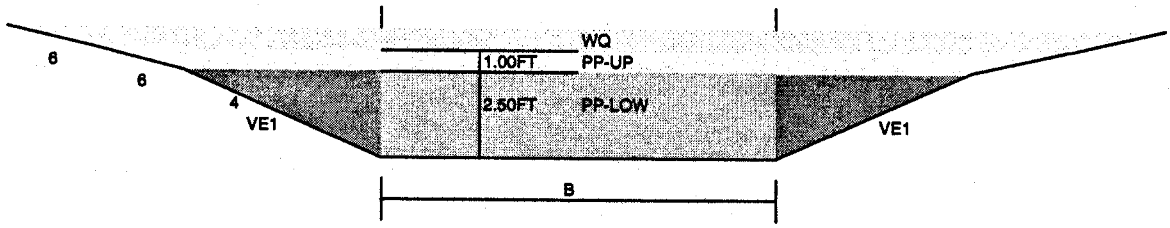
$V_{WQ} + V_{PP} = 0.84$ AC-FT

FOREBAY VOLUME

$0.25\,V_{PP} = 0.25(0.63 \text{ AC-FT})$

$= 0.16$ AC-FT

JN 34358
CALTRANS STORM WATER MANAGEMENT SERVICES
I-5/LA COSTA AVE CONSTRUCTED WETLAND
BASIN DESIGN AND VOLUME CALCULATIONS



FINAL VOLUMES: CALCULATED BY INROADS

	WATER SURFACE ELEVATION m	VOLUME m^3	POOL VOL m^3
	3.000	0.00	
			347.75
PP-LOW	3.780	347.75	
			339.03
	4.065	686.78	
			96.18
PP-UP	4.156	782.96	
			242.49
	4.335	1025.45	
			22.30
WQ	4.349	1047.75	
			240.56
RIM	4.500	1288.31	

WATER SURFACE ELEVATION FT	VOLUME FT^3	POOL VOLUME FT^3	POOL VOLUME AC-FT	
9.840	0.00			
		12271.25	0.28	
12.398	12271.25			
		11963.54	0.27	
13.399	24234.78			
		3394.04	0.08	0.63 AC-FT PP TOTAL
13.632	27628.82			
		8556.80	0.20	
14.219	36185.62			
		787.03	0.02	0.21 AC-FT WQ TOTAL
14.265	36972.65			
		8488.66	0.19	
14.760	45461.31			
				0.84 AC-FT

Calc. By: ______________ Date: 1/30/99
Chkd. By: ______________ Date: __________
Backchkd. By: ______________ Date: __________

JN 34358
CALTRANS STORMWATER MANAGEMENT SERVICES
I-5/LA COSTA AVE CONSTRUCTED WETLAND
1-YEAR Orifice Sizing Calculation

Note: Orifice Sizing Calculation based on procedure for 40 hour drawdown time in Caltrans Storm Water Quality Handbooks Planning and Design Staff Guide. September 1997, PD11B(1) Detention Basin, pg. 6 of 12.

a = area of orifice (ft^2)
$a = (7\times10^{-5}) \times A \times (H-Ho)^{0.5} / CT$

A = Average surface area of the pond (ft^2)
A = 14,760 ft^2
WQ H = Elevation when the pond is full (ft)
H = 14.27 ft
Ho = Permanent Pool (ft)
Ho = 13.63 ft
C = Orifice Coefficient
C = 0.66 for thin materials
T=Drawdown time of full pond (hrs)
T= 24

a = 0.0519 ft^2 Total area required

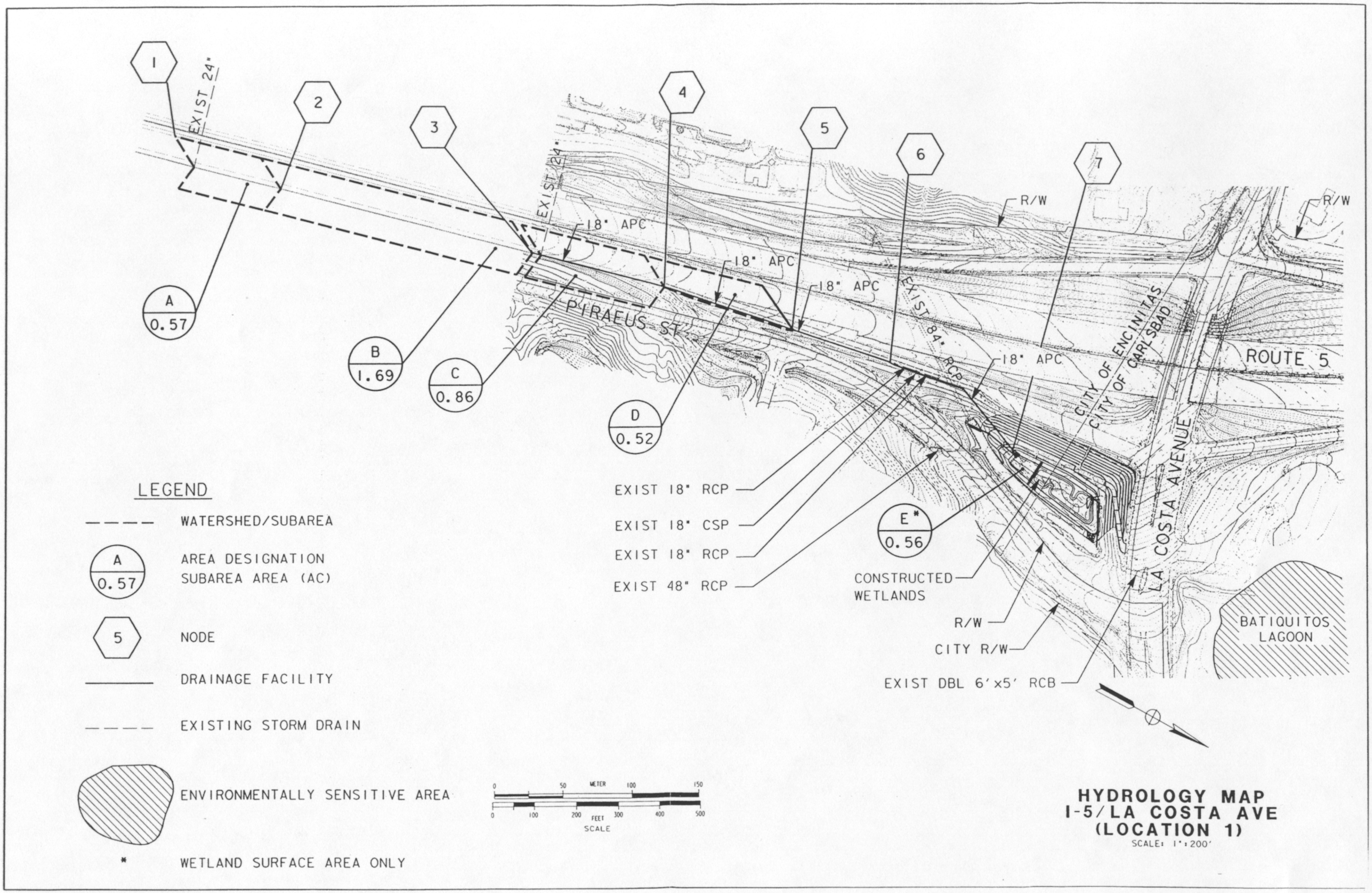
d = diameter of orifice = $(4 \times a / \pi)^{0.5}$
d = 0.26 ft
d = 3.08 in = 78.3 mm

1-YEAR **Use d = 3.08 in (78.3mm) for each orifice to ensure a 24 hour drawdown tir**

Informational Calculations:

T (hrs)	a (ft^2)	d (in)
48	0.0259	2.18
72	0.0173	1.78

APPENDIX C
HYDROLOGY MAPS



HYDROLOGY MAP
I-5/LA COSTA AVE
(LOCATION 1)
SCALE: 1"=200'

APPENDIX D
HYDROSEED MIX RECOMMENDATIONS

CALTRANS STORM WATER MANAGEMENT - BMP RETROFIT PILOT PROGRAM

DESIGN DIRECTIVE MEMORANDUM NO. 6

To:	William Wiedenbacher, Montgomery Watson	Fax No. (619) 239-3895
	Gary Friedman, Montgomery Watson	Fax No. (619) 239-3895
	Glen Grant, Montgomery Watson	Fax No. (209) 547-9344
	Robert Finn, Brown and Caldwell	Fax No. (714) 474-0940
	Douglas Robison, Brown and Caldwell	Fax No. (714) 474-0940
	Ceazar Aguilar, AEI CASC	Fax No. (909) 783-0108
	Erwin Fogerson, AEI CASC	Fax No. (909) 783-0108

From: Mike Chesney, RBF

Copies to:

Steve Borroum, Caltrans HQ	Scott Taylor, RBF MS 140
Kim Noonan, Caltrans HQ	Tom Ryan, RBF MS 140
Pete Van Riper, Caltrans District 7	Bruce Cooke, RBF MS 210
Cid Tesoro, Caltrans District 11	Rhonda Tijerina, RBF MS 210
Christian Herencia, Caltrans District 11	Scott Sawyer, MS 425
Yulya Davidova, Caltrans District 11	Nicole Walker, RBF MS 420
Michael Reader, LKR Group	Ann Walker, RBF MS 140
Steve Huff, RBF MS 425	Sal Sheikh, RBF MS 400

Date: March 11, 1998

Subject: **DESIGN ISSUES AND DIRECTIVES**

Please incorporate the following design directives/elements into your BMP designs:

1. The suggested seed mix for landscaping all exposed/graded areas (excluding the biofiltration strips and swales), and the infiltration basins is as follows:

Botanical Name	Common Name	lbs/acre
Trifolium Willdenovii	Tomcat Clover	3
Vulpia Microstachys	Zorro Grass	5
Lotus Scoparius	Deerweed	3
Hordeum Californicum	California Barley	10
Hordeum Vulgare	Barley	9
Eschschoizia Californica	California Poppy	2
Lupinus Bicolor	Miniature Lupine	4
Nassella Pulchra	Purple Needlegrass	4
Bromus Carinatus "Cucamonga"	Brome Grass	2
Encelia Californica	California Encelia	2

2. As stated previously, the suggested seed mix for the vegetated biofiltration swales and strips is as follows:

   - Trifolium Willdenovii (botanical name), Tomcat Clover (common name) used at 25 lbs/acre.

3. Refugio Dominguez of District 7 stated on Wednesday, March 11, 1998 that the specifications for the District 7 projects being designed by Montgomery Watson and Brown and Caldwell will not require a Traffic Handling section. Refugio stated the District will prepare the traffic handling specifications in-house. The consultants must still prepare traffic handling/stage construction plans.

4. Enclosed you will find RBF's design package with most of the design elements and plan types required. Additionally, we are including RBF's preliminary specifications package for use as a guideline.

Please call me at (714) 855-5792 should you have any comments, questions, or require any additional information.

Martha Blane & Associates
Habitat Restoration Consulting

May 12, 1998

Bill Whittenberg
RBF & Associates
14725 Alton Parkway
Irvine, CA 92618

Project: Caltrans Storm Water Management - Retrofit Pilot Study

Subject: Planting Recommendations for Bio-Filter Strips

Dear Bill:

In response to your request, enclosed herein is information on candidate plant species for planting within the bio-filter strips. Per our discussions and the background information you provided, the species chosen must perform certain functions and meet specific criteria, as follows:

- Filter suspended solids within runoff from paved areas
- Withstand one-year storm events
- Adapt to climate conditions within Caltrans Districts 7 and 11
- Tolerate periods of both high and low moisture
- Be low-growing
- Require little or no maintenance

Species that meet these criteria are shown on Table 1 (attached), along with information on plant life form, height, origin, beneficial/detrimental characteristics and comments. *Trifolium willdenovii* (tomcat clover), which was recommended previously by others, is also included on Table 1 for the purpose of comparison.

Leguminous plant species were researched because of their ability to add nitrogen to soils. Few legume species are available that meet the criteria listed above, particularly adaptability (i.e., drought tolerance) and low maintenance (most are annuals that may require replanting). To obtain some benefit from the use of nitrogen-fixing species, it is recommended that annual leguminous species be planted initially, but without expectation for natural reseeding.

P.O. Box 4093 • San Marcos, CA 92069 • Phone: (760) 471-1245 • Fax: (760) 471-7671

In order to increase the likelihood of adequate plant cover in the shortest possible time, while fulfilling the criteria above, it is recommended that a mixture of species be planted together. This approach is also beneficial in reducing the potential for damage from diseases and pests that could occur with a one-species, monoculture type planting.

A recommended mixture of species for planting within the bio-filter strips is shown on Table 2 (attached). The table shows the preferred planting method, material application rates for seeds and container plant densities for plants.

The availability of suitable plant species grown as sod was researched. None of the species shown in Table 1 or 2 are grown as sod since there is not an established market for them and most species are not sod forming. It may be possible to request that some species be contract grown (e.g., saltgrass and creeping wildrye) as sod. However, even if a grower agreed to grow sod, there is high risk for failure since it is not a usual practice.

The plant material that can be obtained in a sod-like form is saltgrass. It is grown in flats (±18" x 18") and may be purchased at Tree of Life Nursery in San Juan Capistrano (714.728.0685). However, as shown in Table 2 and described above, planting "plugs" from cut-up flats, along with other species, is recommended.

All seed and plant materials should be ordered well in advance of need to ensure availability. For example, Tree of Life Nursery currently has ±15 flats of saltgrass available. They indicated that it takes about three months (during the warm season) to grow a flat of saltgrass. The needlegrass species are also currently available, but, availability changes on a daily basis.

Per your request, the seed/plant mixture shown on Table 2 was compared to the seed mix presented in Design Directive Memorandum No. 6 (March 11, 1998) to determine which would be more appropriate for general erosion control. Of the two choices, I believe the seed mix shown in Memo. No. 6 would be the better choice. The reason for this is that there are two shrub species included, along with several grass species and a few legumes. The shrubs are the primary difference, and they will add greater diversity in stature, root system, and possibly the longevity of the plantings.

If you need information on other plant mixtures/assemblages, additional lists could be developed. Please contact me with any questions or comments and/or if you would like further assistance.

Sincerely,

Martha Blane

Martha Blane

Attachments: Table 1
Table 2
References and Sources of Information

TABLE 1
PLANT SPECIES SUITABLE FOR BIO-FILTER PLANTINGS

Genus species	Common Name	Life Form	Height	Origin/Range
Bromus carinatus	California brome	grass, perennial, short-lived (± 2 years)	18" - 36"	Western US, British Columbia to Central America
Deschampsia caespitosa	Tufted hairgrass	grass, perennial, clumping	12" - 30"	North America
Distichlis spicata	Saltgrass	grass, perennial, rhizome/stolon forming	6" - 20"	North America to South America
Elymus glaucus	Blue wildrye	grass, perennial, clumping	18" - 36"	Alaska to Baja California
Hordeum brachyantherum	Meadow barley	grass, perennial, clumping	12" - 18"	North America to Baja California
Leymus triticoides "Rio"	Creeping wildrye	grass, perennial, creeping rhizomes	18" - 36"+	Western US and Baja California
Lupinus bicolor	Pygmy-leaf lupine	legume, annual	4" - 12"	California deserts, mountains and coastal areas
Nasella lepida	Foothill needlegrass	grass, perennial, clumping	12" - 24"	Northern California to Baja California
Nasella pulchra	Purple needlegrass	grass, perennial, clumping	12" - 24"	Northern California to Baja California
Trifolium willdenovii	Tomcat clover	legume, annual	4" - 16"	Western North America

TABLE 1
(Continued)

Genus species	Common Name	Benefits	Detriments	Comments
Bromus carinatus	California brome	Fast-growing, adapted to drought and poor soils.	Short-lived, may be too tall	Often used for soil stabilization and revegetation.
Deschampsia caespitosa	Tufted hairgrass	Grows in dense stands, adapted to moist soils, recovers well from disturbance.	May be too tall, too dense and require too much moisture.	Important range species, widely distributed, sometimes used for erosion control.
Distichlis spicata	Saltgrass	Stout, hardy, adapts to harsh soil conditions (wet or dry) and silt build-up, recovers well from disturbance.	Foliage may turn brown during coldest months.	Spreads by creeping stolons (similar to Bermuda grass in appearance, but not as vigorous), can form a tough mat-like cover.
Elymus glaucus	Blue wildrye	Fast-growing, fast-spreading, good for erosion control.	May be too tall.	Foliage is bluish-green.
Hordeum brachyantherum	Meadow barley	Fast-growing, begins spring growth early, tolerates moist soils.	May be short-lived.	Can provide cover while slower-growing species become established.
Leymus triticoides "Rio"	Creeping wildrye	Tolerates harsh conditions, heavy soils, forms a dense ground cover, long-lived.	May be too tall and too dense.	Stays green late into summer.
Lupinus bicolor	Pygmy-leaf lupine	Nitrogen-fixing, adapts to many soils, germinates early.	Annual, may not reseed if other vegetation is present.	Frequently included in erosion control and revegetation seed mixes.
Nasella lepida	Foothill needlegrass	Adapted to drought and poor/disturbed soils, long-lived, low fuel.	Best in well-drained soils.	Common component of California grasslands; often used for revegetation.
Nasella pulchra	Purple needlegrass	Adapted to drought and poor/disturbed soils, long-lived, low fuel.	Best in clayey soils.	Major component of California grasslands; often used for revegetation.
Trifolium willdenovii	Tomcat clover	Nitrogen-fixing, adapts to heavy soils, germinates early.	Annual, may not reseed.	Seed recently became available for erosion control and revegetation plantings.

TABLE 2

RECOMMENDED SPECIES MIXTURE FOR BIO-FILTER PLANTINGS(1)

Genus species	Common Name	Seed Application Rate Per Acre %Purity/%Germination	Container Plant Spacing and Container Size/Type
Bromus carinatus	California brome	6.0 pounds per acre 95/80	--
Distichlis spicata	Saltgrass	--	12" on-center spacing of "plugs" from cut-up flats
Deschampsia caespitosa	Tufted hairgrass	1.0 pound per acre 80/60	--
Hordeum brachyantherum	Meadow barley	5.0 pounds per acre 90/80	--
Lupinus bicolor	Pygmy-leaf lupine	3.0 pounds per acre 98/80	--
Nasella lepida	Foothill needlegrass	--	12" on-center spacing of groove tubes (2" deep x 3/4" wide)
Nasella pulchra	Purple needlegrass	--	12" on-center spacing of groove tubes (2" deep x 3/4" wide)
Trifolium willdenovii	Tomcat clover	1.5 pounds per acre 95/75	--

1. Seed and container plant recommendations based on which material will provide the most reliable and fastest cover. Some container species are also available as seed.

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APPENDIX E
ENGINEERING COST ESTIMATES

ENGINEER'S ESTIMATE

Item	Item Code	Item	Unit of Measure	Estimated Quantity	Unit Price (In Figures)	Item Total (In Figures)
1	074019	PREPARE STORM WATER POLLUTION PREVENTION PLAN	LS	LUMP SUM	LUMP SUM	10,000.00
2	074020	WATER POLLUTION CONTROL	LS	LUMP SUM	LUMP SUM	5,000.00
3	120090	CONSTRUCTION AREA SIGNS	LS	LUMP SUM	LUMP SUM	3,500.00
4	120100	TRAFFIC CONTROL SYSTEM	LS	LUMP SUM	LUMP SUM	3,500.00
5	013370	TRAFFIC PLASTIC DRUMS	EA	7	50.00	350.00
6	129000	TEMPORARY RAILING (TYPE K)	M	486	35.00	17,010.00
7	129100	TEMPORARY CRASH CUSHION MODULE	EA	19	300.00	5,700.00
8	160101	CLEARING AND GRUBBING	LS	LUMP SUM	LUMP SUM	5,000.00
9	190101	ROADWAY EXCAVATION	M^3	9300	12.00	111,600
10	193118	CONCRETE BACKFILL	M^3	22	200.00	4,400
11	200001	HIGHWAY PLANTING	LS	LUMP SUM	LUMP SUM	15,000.00
12 (S)	203016	EROSION CONTROL (TYPE D)	HA	0.06	5000.00	300.00
13	204053	WILD FLOWER SEEDING	KG	3.5	850.00	2,975.00
14	204099	PLANT ESTABLISHMENT WORK	LS	LUMP SUM	LUMP SUM	21,600.00
15	260201	CLASS 2 AGGREGATE BASE	M^3	98	30.00	2,940.00
16	390155	ASPHALT CONCRETE (TYPE A)	TONN	31	45.00	1,395.00
17	400000A	POROUS PAVERS	M^2	380	22.00	8,360.00
18 (F)	510502	MINOR CONCRETE (MINOR STRUCTURE)	M^3	15	1100.00	16,500.00
19	620909	450 MM ALTERNATIVE PIPE CULVERT	M	424	200.00	84,800

ENGINEER'S ESTIMATE

20	641120A	50 MM PLASTIC PIPE	M	4	20.00	80.00
21	641122A	150 MM PLASTIC PIPE	M	31	25.00	775.00
22	641124A	200 MM PLASTIC PIPE	M	1	50.00	50.00
23	70600A	CANAL GATE	EA	2	10,000	20,000.00
24	70610A	PALMER-BOWLUS FLUME	EA	1	3,000	3,000.00
25	721011	ROCK SLOPE PROTECTION (BACKING NO. 2, METHOD B)	M^3	30	100	3,000.00
26	721810	SLOPE PAVING (CONCRETE)	M^3	2	400	800.00
27	722022A	GABION WALL	LS	LUMP SUM	LUMP SUM	6,000.00
28	728000A	BASIN LINING	M^2	1680	8.00	13,440.00
29	729010	ROCK SLOPE PROTECTION FABRIC	M^2	50	5.00	250.00
30 (S-F)	750001	MISCELLANEOUS IRON AND STEEL	KG	1421	10.00	14,210.00
31	802596	3.7 M CHAIN LINK GATE (TYPE CL-1.8)	EA	1	1,000	1,000.00
32	999990	MOBILIZATION	LS	LUMP SUM	LUMP SUM	38,255.00
					SUBTOTAL CONTRACT ITEMS	420,790.00
					5% CONTINGENCY	21,040.00
					GRAND TOTAL	441,830.00

APPENDIX F
CONSTRUCTED WETLAND DESIGN GUIDELINE

Constructed Wetlands

Introduction

Wetlands provide physical, chemical, and biological water quality treatment of stormwater runoff. Physical treatment occurs as a result of decreasing flow velocities in the wetland, and is present in the form of evaporation, sedimentation, adsorption, and/or filtration. Chemical processes include chelation, precipitation, and chemical adsorption. Biological processes include decomposition, plant uptake and removal of nutrients, plus biological transformation and degradation. Hydrology is one of the most influential factors in pollutant removal due to its effects on sedimentation, aeration, biological transformation, and adsorption onto bottom sediments (Dorman et al., 1996). The large surface area of the bottom of the wetland encourages higher levels of adsorption, absorption, filtration, microbial transformation, and biological utilization than might normally occur in more channelized watercourses (Young, et al, 1996). A schematic diagram of a constructed wetland is shown in Figure 1.

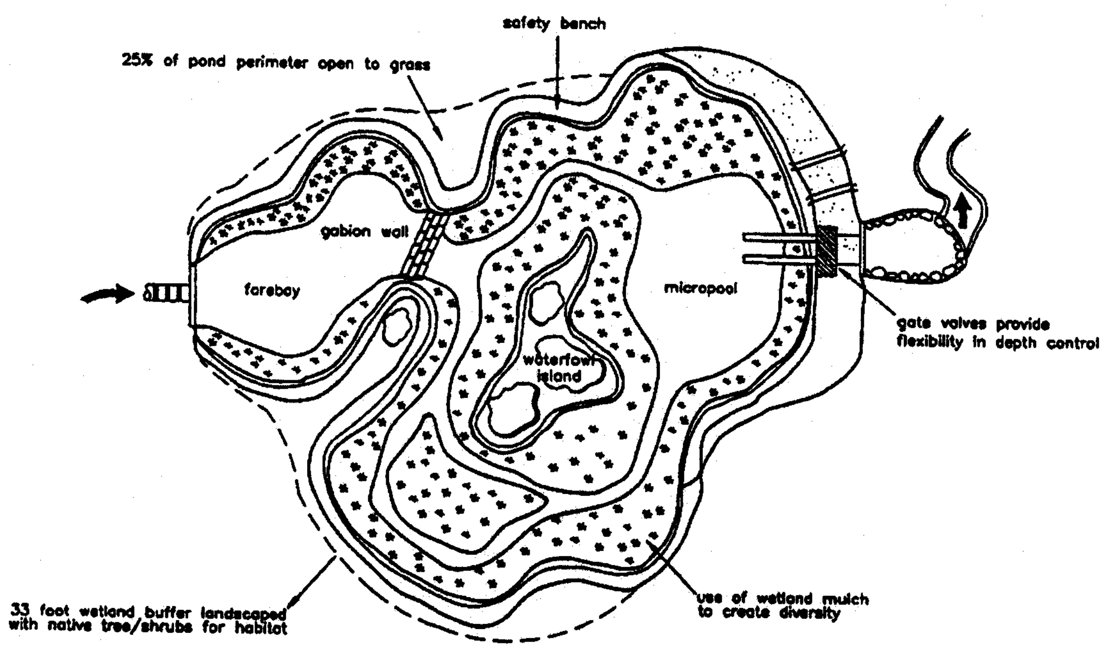

Figure 1 Schematic of a Constructed Wetland (Schueler et al, 1992)

Artificial wetlands offer natural aesthetic qualities, wildlife habitat, erosion control, and pollutant removal. Artificial wetlands can offer good treatment following treatment by other BMPs, such as wet ponds, that rely upon settling of larger sediment particles (Urbonas, 1992). They are useful for large basins when used in conjunction with other BMPs. Wetlands do have some disadvantages in that a continuous base flow is required. If not properly maintained, wetlands can accumulate salts and scum which can be flushed out by large storm flows. Another disadvantage is that regular maintenance, including plant harvesting, is required to provide nutrient removal. Sediment removal is also required to maintain the proper functioning of the wetland (Young et al, 1996).

The success of a wetland will be much more likely if some general guidelines are followed. The wetland should be designed such that a minimum amount of maintenance is required and maintenance is facilitated (use of a sediment forebay for example). This will be affected by the plants, animals, microbes, and hydrology. The natural surroundings, including such things as the potential energy of a stream or a flooding river, should be utilized as much as possible. It is necessary to recognize that a fully functional wetland cannot be established spontaneously. Time is required for vegetation to establish and for nutrient retention and wildlife enhancement to function efficiently. Also, the wetland should approximate a natural situation as much as possible, and unnatural attributes, such as a rectangular shape or a rigid channel, should be avoided (Young et al, 1996).

Site Selection

Site considerations should include the water table depth, soil/substrate, and space requirements. Because the wetland must have a source of flow, it is desirable that the water table is at or near the surface. This is not always possible. If runoff is the only source of inflow for the wetland, the water level often fluctuates and establishment of vegetation may be difficult. The soil or substrate of an artificial wetland should be loose loam to clay. A perennial baseflow must be present to sustain the artificial wetland. The presence of organic material is often helpful in increasing pollutant removal and retention. A greater amount of space is required for a wetland system than is required for a detention facility treating the same amount of area (Dorman et al, 1996).

General Selection Criteria (NCTCOG, 1993)

- Need to achieve high level of particulate and some dissolved contaminant removal
- Ideal for large, regional tributary areas
- Multiple benefits of passive recreation (e.g., bird watching, wildlife habitat)
- Never use natural or mitigated wetlands as a treatment device

Limitations (NCTCOG, 1993)

- Concern about mosquitoes
- Cannot be placed on steep slopes
- May need base flow or supplemental water to maintain wetland vegetation
- May be infeasible to site or retrofit in dense urban areas
- Nutrient release may occur during winter
- Overgrowth may lead to reduced hydraulic capacity
- Agencies may claim as wetlands and restrict maintenance

Specific Site Selection Criteria

- Source of perennial flow (groundwater/surface water)
- Type of soil (loose loam/clay)
- Space available: Maintenance access, permanent storage and detention volume, areas to create shallow and open water, inlet and outlet, including sediment forebay.

Design Guidelines

Constructed wetlands are shallow pools with or without open water elements that create growing conditions suitable for marsh plants. Conventional stormwater wetlands are shallow manmade facilities supporting abundant vegetation and a robust microbial population. These facilities are generally designed as offline BMPs, but may be situated online if flows from extreme events can be accommodated without damage to the facility. Wet basins are deeper, with little to no vegetation, but incorporate a permanent pool. The proposed design for the subject site is a constructed wetlands with open water elements similar to a wet basin.

Constructed wetlands are capable of excellent pollutant removal if sized and designed properly. Performance is generally good with respect to settling of the solids fraction and for the dissolved constituents as well due to active microbial action. Enhanced design elements include a sediment forebay, micropool areas, a complex microtopography, pondscaping, and multiple species of wetlands trees, shrubs and plants. As with wet basins, a consistent source of water is necessary to sustain the system; thus, in smaller and urban applications, treated water may be required to supplement natural sources. Maintenance requirements are most intensive during the early stages when the wetlands is being established.

(1) *Facility Sizing* – The size of the facility is determined by the water quality volume and the volume of the permanent pool. The water quality capture volume is equal to the runoff from the 1-yr, 24-hour storm and should be provided above the level of the permanent pool. The permanent pool volume should provide for a minimum of a 14-day retention; therefore, the volume is equal to one-half of the runoff volume of the wettest month of the year. The permanent pool volume should be increased by a factor of 10% to accommodate reduction in the available storage volume due to deposition of solids in the time between full-scale maintenance activities.

(2) *Pond Configuration* - Stormwater constructed wetlands offer significant flexibility regarding pond configuration with the exception that short-circuiting of the facility must be avoided. Provision of irregular, multiple flow paths is desired and can be created with the use of berms as shown in Figure 2. The use of open water elements (micropools) is recommended, especially near the facility outlet, both as a means of diversifying the biological community and as an aesthetic consideration. Islands may be placed in the facility to enhance waterfowl habitat and placement of trees, but will most likely not be incorporated in the proposed

design due to space limitations. At least 25 percent of the basin should be an open water area at least 0.6-m (2-ft) deep if the device is exclusively designed as a shallow marsh. The open-water area will make the marsh area more aesthetically pleasing, and the combined water/wetland area will create a good habitat for waterfowl (Schueler, 1987). The combination of forebay, outlet and free water surface should be 30 to 50 percent, and this area should be between 0.6- and 1.2-m (2- and 4-ft) deep. The wetland zone should be 50 to 70 percent of the area, and should be 150- to 300-mm (6- to 12-in) deep.

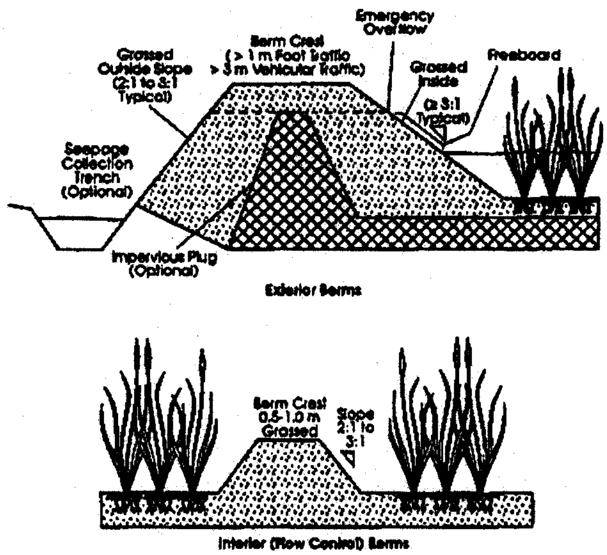

Figure 2 Examples of Wetland Berms (Kadlec and Knight, 1996)

(3) *Sediment Forebay* - A sediment forebay is required to isolate gross sediments as they enter the facility and to simplify sediment removal and will be used for the site. The sediment forebay should consist of a separate cell formed by an earthen berm, gabion wall, or loose riprap wall. The forebay shall be sized to contain 0.25 inches per impervious acre of contributing drainage area and should be 2-4 feet deep. Direct maintenance access should be provided to the forebay. A fixed vertical sediment depth marker should be installed in the forebay to mark sediment accumulation.

(4) *Vegetation* - A diverse, locally appropriate selection of plant species is vital for all constructed wetlands. A planting plan swill be prepared that indicates number of plants from each species to be used and how aquatic and terrestrial areas will be vegetatively stabilized. Participation of a wetlands designer or landscape architect familiar with local plants will be employed. Some of the wetland species appropriate for a warm weather climate and the planting guidelines are shown below (City of Austin, 1997).

Wetland Plant List

Install Bulrush in clumps, with individual plants spaced approximately three to four feet on center: At least two of the following species should be used:

BULRUSH	WATER DEPTH	NOTES
Scirpus validus, Bulrush	1' — 3'	8' tall evergreen, resists cattail encroachment
Scirpus californicus, Bulrush	1' — 3'	8' tall evergreen, resists cattail encroachment
Scirpus americanus, Three-square bulrush	2" — 6"	2' to 4' tall, w/ 3 distinct edges

Install Spikerush at or near the water's edge, with individual plants spaced approximately three to six feet on center. At least two of the following species should be used:

SPIKERUSH	WATER DEPTH	NOTES
Eleocharis montevidensis, Spikerush	0" — 6"	1' tall, rhizomatous, reduces erosion at the pond edge
Eleocharis macrostachys, Spikerush	0" — 6"	1' tall, rhizomatous, reduces erosion at the pond edge
Eleocharis quadrangulata, Spikerush	3" — 1'	2' to 2.5' tall, rhizomatous, can accommodate deeper water, 4-angled

At least two species of the following marsh plants shall be used (additional species are encouraged). Install in clumps in shallow water, with individual plants spaced at approximately three feet on center:

MARSH DIVERSITY	WATER DEPTH	NOTES
1. Cyperus ochraeus, Flatsedge	2"—6"	1' to 2' tall, clump-forming, common to central Texas
2. Dichromena colorata, White-topped Sedge	2" —6"	1' to 2' tall, white bracts during warm season
3. Echinodorus rostratus, Burhead	3' - 1'	1' to 2' tall, annual, heart-shaped leaves, flower similar to arrowhead
4. Eleocharis quadrangulata, Four-square Spikerush	6" — 1'	1' to 2' tall, colonizes, inhabits deeper water than other Spikerushes
5. Iris Pseudacorus, Yellow Flag Iris	1' — 2'	3' to 4' tall. can be invasive, dense growth, yellow flowers
6. Junctus effusus, Soft Rush	6" — 1'	3' to 4' tall, forms a tight clump, evergreen, very attractive
7. Justicia americana, Water willow	2" — 6"	2' to 3' tall, common, white flowers, herbaceous, colonizes
8. Marsilea macropoda, Water Clover	2" — 6"	Looks like floating four-leaf clover, endemic to Texas
9. Najas guadalupensis, Water-	1' —4'	Submergent, valuable to fish and

Naiad		wildlife
10. Pontederia cordata, Pickerelweed	2" — 1'	3' tall, colonizes, cosmopolitan, purple flowers
11. Rhynchospora corniculata, Horned-rush	2" — 6"	2' to 3' tall, brass-colored flowers in May

Install Arrowhead in clumps in shallow water, with individual plants spaced approximately three feet on center.

ARROWHEAD	WATER DEPTH	NOTES
Saggitaria latifolia, Arrowhead	2" — 1'	2' height, wildlife value, white flowers, proven water quality performer

Floating-leaved aquatic plants are rooted in the sediment of the pond, and have leaves that float on the surface of the water. These leaves shade the water, which limits potential algae growth. At least two of the following species should be used and should be placed at random locations throughout the pond:

AQUATICS	WATER DEPTH	NOTES
1. Cabomba caroliniana, Fanwort	1' — 4'	Approximately 6' length underwater, submergent
2. Ceratophyllum spp., Coon-tail	1' —4'	Maximum 8' length, tolerant of turbidity and water fluctuation, wildlife food
3. Nymphaea odorata, Fanwort	6" —2'	A native, reliably hardy, floating- leaved aquatic, with white flowers
4. Potomageton pectinatus, Sago Pondweed	8" — 3'	Colonizes quickly, valuable to fish and wildlife; floating-leaved aquatic

(5) *Outflow Structure* - The low flow orifice should be sized so that the water quality volume above the permanent pool empties in 24 hours. This emptying time is not for the wetland itself, but for the additional storage above the wetland. The facility should have a separate drain pipe with a manual valve that can completely or partially drain the pond for maintenance purposes. To allow for possible sediment accumulation, the submerged end of the pipe should be protected, and the drain pipe should be sized one pipe schedule higher than the calculated diameter needed to drain the pond within 24 hours. The valve shall be located at a point where it can be operated in a safe and convenient manner. A number of possible outlet designs are shown in Figure 3. For online facilities, the principal and emergency spillways should be sized to provide 1.0 foot of freeboard during the 25-year event and to safely pass the 100-year flood. The embankment should

be designed in accordance with all relevant state and federal specifications for small dams as appropriate.

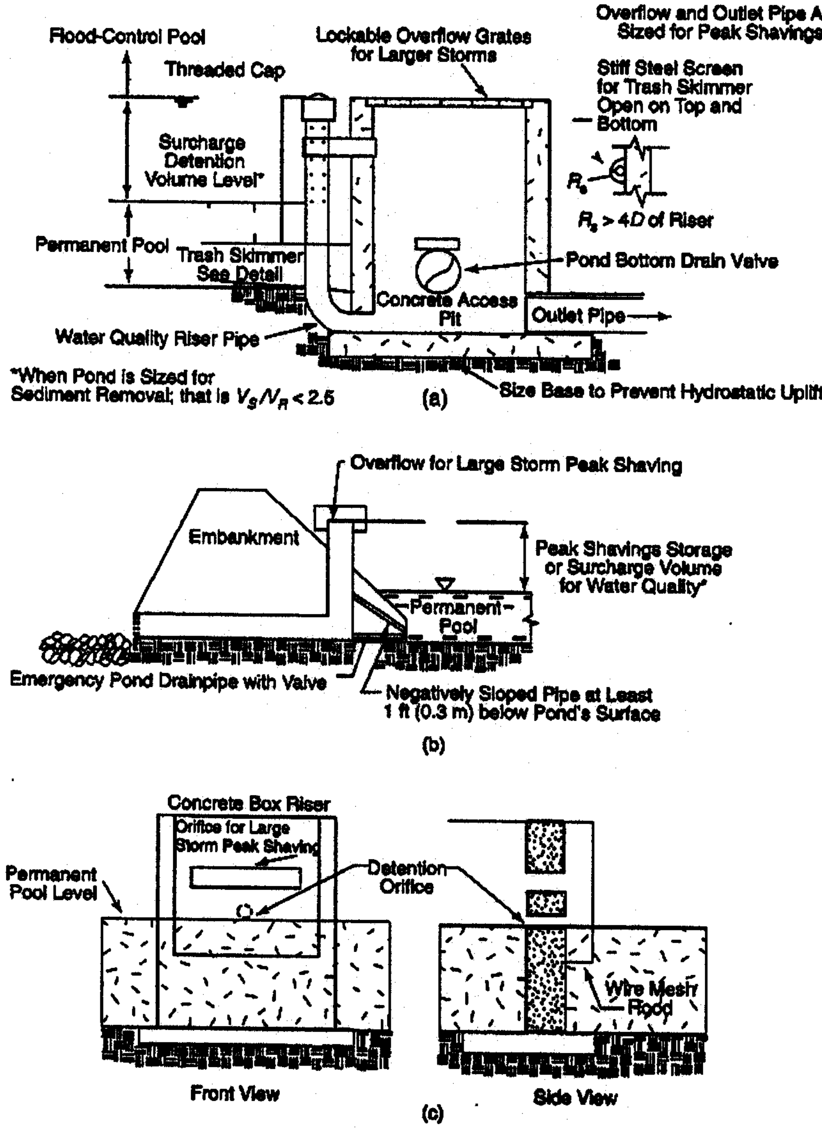

Figure 3 Schematic Diagrams of Wet Basin Outlets (WEF and ASCE, 1998)

(6) *Depth of Inundation During Storm Events* - The depth of inundation of the facility above the normal pool elevation should not exceed 2.0 feet during the 25-year event.

(7) *Offline Configuration* - Offline configuration of the facility is preferred except where the designer can demonstrate that extreme events will not encourage scour or other damage to the wetlands. An offline design will be used for the proposed Caltrans retrofit site. When the wetland is designed as an offline facility, a splitter structure is used to isolate the water quality volume. The splitter box, or other

flow diverting approach, shall be designed to convey the 25-year to the storm drain system. Surcharge in the pond during greater than design events will provide at least 0.5 foot of freeboard along the wetland sideslopes.

(8) *Mosquito Control* – Mosquito control will be achieved through the introduction of *Gambusia* (mosquito fish). Gambusia should be stocked at a minimum initial density of 200 individuals per surface acre (City of Austin, 1997).

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USED TO ESTIMATE VOLUME OF PERMENANT POOL.

Encinitas, CA Monthly Rainfall Averages
1997-98 Rainfall Season
County of San Diego Flood Control – (619)495-5557

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Average	.06"	.09"	.19"	.32"	1.26"	1.44"	2.45"	1.99"	2.18"	.74"	.23"	.08"
Yrs of Record	33	33	33	33	35	35	35	35	35	35	34	35

Average Annual Rainfall – 11.03"

MAXIMUM RAINFALL = 2.45" – JAN

$Q = CIA$ $\qquad I = \frac{MAX}{2}$ – 14 DAY

$= 0.9 \left(\frac{2.45''}{2} \right) 4.2\ AC$

$= 4.63$ AC-IN

+ 10%

$4.63(1.1) = 5.09$ AC-IN $\left(\frac{FT}{12 IN} \right)$

$= 0.42$ AC-FT

APPENDIX G
WETLAND PLAND SPECIES RECOMMENDATIONS

JNE & ASSOCIATES, INC. 619 222-0016
ENVIRONMENTAL CONSULTING

November 20, 1998

Mr. ~~Trevor~~ Smith Ann Walker
Robert Bein, William Frost & Associates
14725 Alton Parkway
Irvine, CA 92618-2089

Re: Plants for I5/La Costa Wet Basin

Dear Trevor,

Following is a table of plant species that could be planted within the wet basin site. The table provides the species name, the zone in which the plant should be planted, the spacing, and anticipated rooting depth of each species.

The table begins with Zone 2 (shallow water bench) with water depths of 6 to 12". We understand there will be instances when the water is deeper, however we are providing vegetation cover for habitat that normally exists in southern California basins during typical conditions.

Zone 3 represents the edge of water during a small storm event. Zone 4 is considered the riparian area and is at the inundation line of an annual event. Zone 5 is the floodplain terrace represented by the elevation of a 2-year storm event. Zone 6 is upland slopes having little or no inundation unless a major storm event occurred.

If you have any questions, please do not hesitate to call me at (619) 222-0016.

Cordially,

Jean A. Nichols, Ph.D.
President

JN:hs

Attachment: plant list

Seed Mix for Wet Basin

Hydroseed mix for Zones 2, 3 and 4:

Artemisia douglasiana	4 pounds per acre
Baccharis salicifolia	1 pound per acre
Haplopappus venetus	2 pounds per acre
Lasthenia californicum	5 pounds per acre
Limonium californicum	5 pounds per acre

Hydroseed mix for Zones 5 and 6:

Artemisia californica	4 pounds per acre
Eriogonum fasciculatum	4 pounds per acre
Eschscholzia californica	3 pounds per acre
Lasthenia glabrata	5 pounds per acre
Lotus scoparius	2 pounds per acre
Salvia mellifera	2 pounds per acre

Wet Basin Design

Zone	Species	Spacing	Root Depth
2 Shallow Water Bench	Scirpus californicus (rooted liners)	12- 24 inches on center	Shallow rooted, not more than 12 inches
	Scirpus robustus (rooted liners)	12- 24 inches on center	Shallow rooted, not more than 12 inches
	Typha latifolia (rooted liners)	12- 24 inches on center	Shallow rooted, not more than 12 inches
3 Water Fringe	Juncus acutus (rooted liners)	12- 24 inches on center	Shallow rooted, not more than 12-18 inches
	Frankenia grandifolia (one gallon)	12- 24 inches on center	Shallow rooted, not more than 12 inches
	Limonium claifornicum (one gallon)	12- 24 inches on center	Shallow rooted, not more than 12 inches
	Baccharis sallcifolia (one gallon)	3 feet on center	Moderately rooted 18 to 24 inches
4 Riparian	Salix goodingii (one gallon)	6 feet on center	Deep rooted 5 to 6 feet
	Sambucus mexicanus (one gallon)	6 feet on center	Deep rooted 3 to 5 feet
	Salix lasiolepis (one gallon)	6 feet on center	Deep rooted 5 to 6 feet
	Atriplex lentiformis (one gallon)	6 feet on center	Deep rooted 4 to 5 feet
5 Floodplain fringe	Salix goodingii (one gallon)	6 feet on center	Deep rooted 5 to 6 feet
	Platanus racemosa (one gallon)	20 feet on center	Deep rooted 6 feet minimum
	Distichlis spicata (plugs)	Plugs spaced every 24 inches	Shallow rooted less than 12 inches
6 Upland Fringe	Haplopappus venetus (one gallon)	6 feet on center	Moderately rooted 18 to 24 inches
	Mimulus longflorus (one gallon)	4 feet on center	Moderately rooted 18 to 24 inches
	Baccharis pilularis (one gallon)	6 feet on center	Moderately rooted 18 to 24 inches